

DEVELOPMENT OF HIGH MISALIGNMENT CARBON SEALS: OVERVIEW

Lou Dobek
Pratt & Whitney
East Hartford, Connecticut



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Development of High Misalignment Carbon Seals (UEET)

Lou Dobek



High Misalignment Carbon Seals

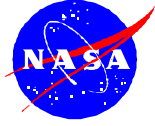
Background

Advanced Commercial Engines will be subjected to extreme conditions such as:

- High angular and radial seal misalignments
 - Gyroscopic loads - angular misalignment
 - Sun input gear orbiting - radial/eccentric misalignment
- Higher LPC shaft speed; ~10,000 RPM
- Large Diameter Fan Hub

Seals capable of accomodating high misalignment levels, high rubbing speeds, low pressure differentials and large diameters must be developed

Background information on principal causes of extreme conditions in Advanced Commercial Engines. Such conditions impose on seals high misalignment, high rubbing speed, large diameters and low pressure differentials.



High Misalignment Carbon Seals

FY 00 Objectives:

- Demonstrate feasibility of new seal designs for advanced engine environments
- Enabling technology for Geared Fan Engine

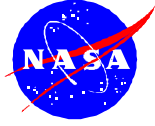
High Misalignment Seal - determine misalignment capabilities of existing circumferential segmented seals and develop design(s) to meet requirements.

Other industry applications

benefiting from new seal technology

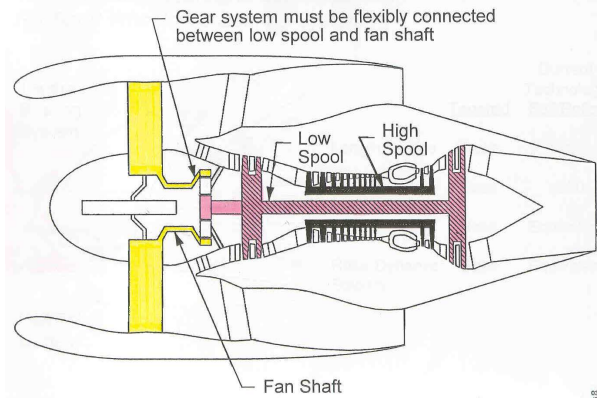
- F119 - Circumferential segmented seal employed
- Higher thrust GTF to use a 16" diameter seal
- High speed high misalignment seal applications
- Other aircraft engine manufacturers will see improved background in today's size, speed and misalignment seal capabilities

Overview of FY'00 objectives: start development of the high misalignment seal with baseline testing. Other possible industry beneficiaries of improved seal technology are also listed.



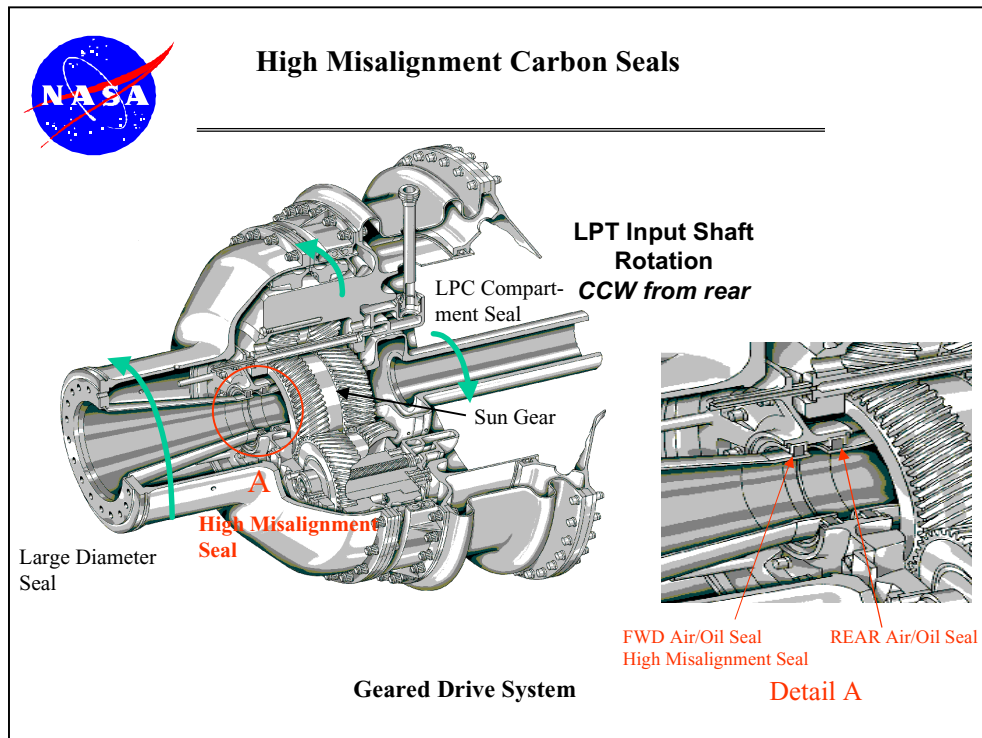
High Misalignment Carbon Seals

GTF

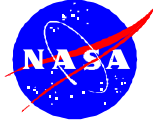


Geared Turbo Fan Schematic

Sketch of Geared Turbo Fan position and connection to the rest of the engine. Input shaft to GTF is connected to LPC shaft and the GTF output shaft is connected to the fan shaft.



Cutaway 3D sketch of the Geared Drive showing location of misalignment seal.

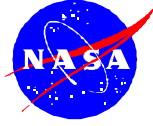


High Misalignment Carbon Seals

	FWD. AIR/OIL SEAL	REAR AIR/OIL SEAL	FDGS/LPC COMPARTMENT SEAL	FDGS COMP. FWD SEAL
Required Life (hours)	30,000	30,000	30,000	30,000
Delta P (psi)	<50	<50	40-50	~0
Surface Speed (ft/s)	50	129	380	200
Buffer Air Supply Temperature (deg. F)	350	350	415	
Angular Misalignment (deg)	0.5	0.2	0.1	
Eccentricity (inches)	0.005	0.02	0.005	
Sealing Diameter (inches)	2.95	2.95	8.7	16
Type	Segmented/ bellows/ other	Segmented/ other	Segmented/ ring/ other	Segmented/ Face/ Cartridge

Seal Operating Conditions

Seal operating conditions (required life, pressure differentials, speeds, misalignment levels and others). Critical requirements are highlighted.



High Misalignment Carbon Seals

Misalignment Seal Test Rig Program

Technical Approach

Pratt & Whitney selected Stein Seal as the seal vendor.

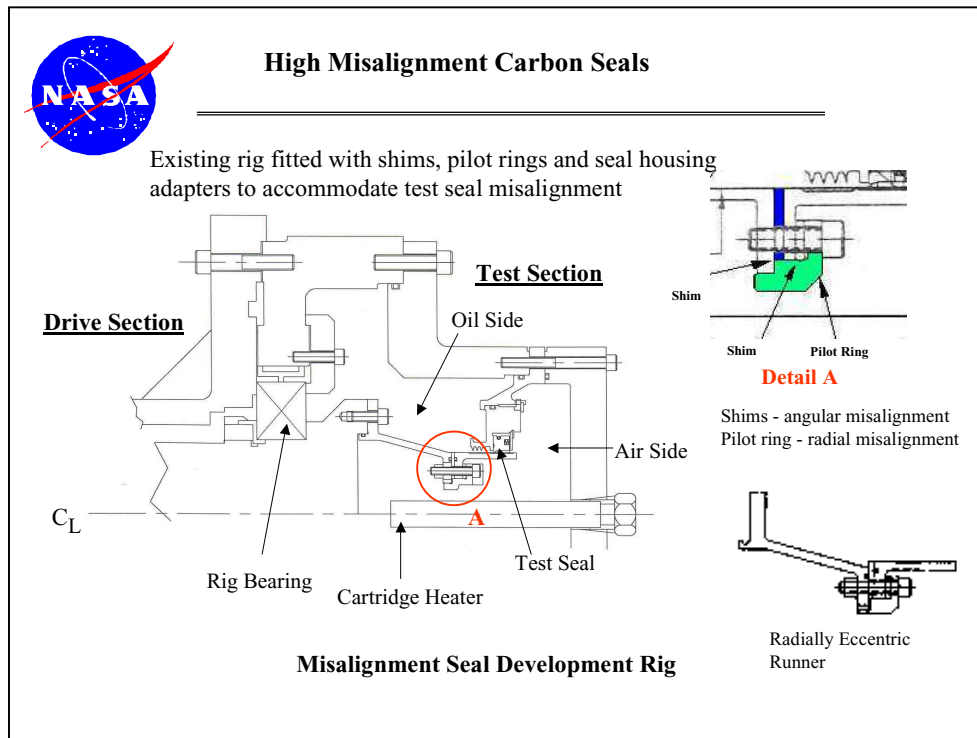
Testing at supplier's facilities.

- Step 1- Start with "baseline" seal with 0.020 in. shaft clearance.
Carbon grade: Carbone JP1000 - high strength, low modulus.
Testing in this phase will not include endurance.
Misalignment level increased in steps.
- Step 2 - Modify baseline seal to attain 0.040 in. shaft clearance.
- Step 3 - Increase shaft clearance to 0.060, 0.080, 0.1 in.

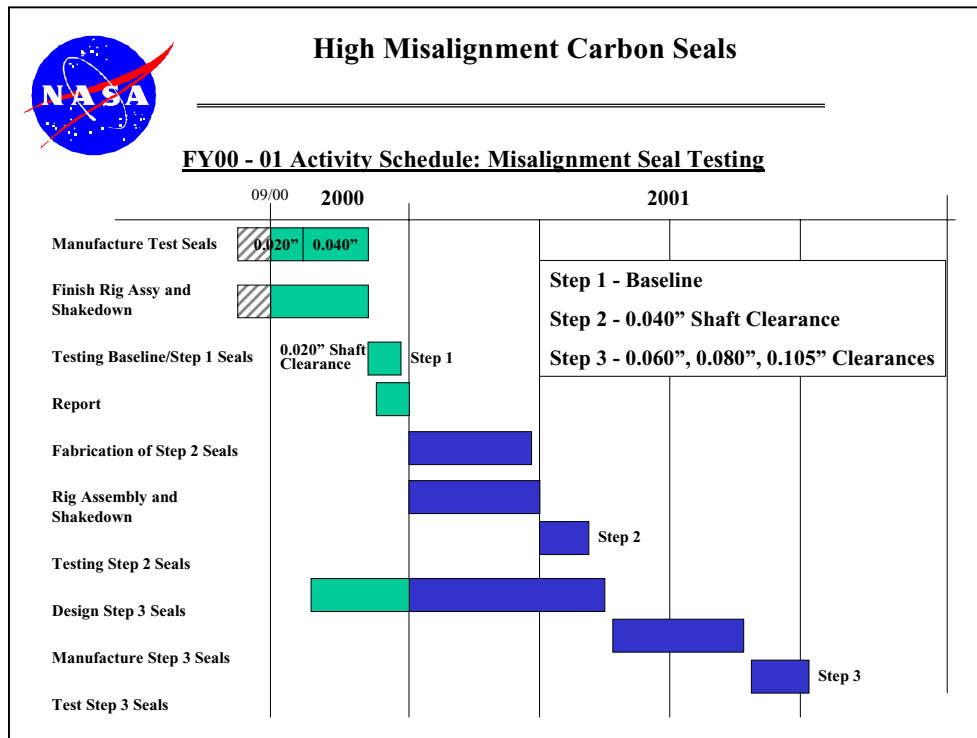
Backup plan in case carbon fails includes seal re-design and testing.

- Two backup design schemes being examined.
- Alternative carbon grade being considered.

Technical approach of misalignment seal development program. Three main steps will be followed starting from a "baseline" seal testing.



Sketch of misalignment seal rig. Simulation of angular and radial misalignment achieved by means of shims and pilot rings tilting and translating seal runner.



Activity schedule for FY'00 and FY'01. Three main steps needed to develop high misalignment carbon seals for the GTF application.